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Continuing Engineering Education

Volume 3, No. 16
November 15, 1981

CALENDAR

OF SELECTED COMMUNICATIONS COURSES

from classes scheduled for November/December, 1981

DIGITAL ENCODING AND PROCESSING OF VOICE AND VIDEO	November 9-11, 1981 Course No. 451DC
SWITCHED TELEPHONE NETWORKS: SWITCHING CONCEPTS	November 9-11, 1981 Course No. 490DC
TDMA SATELLITE SYSTEM ENGINEERING AND PRACTICE	November 9-12, 1981 Course No. 790DC
TACTICAL MISSILE GUIDANCE AND CONTROL	November 9-13, 1981 Course No. 865DC
DIGITAL TRANSMISSION SYSTEMS ENGINEERING	November 16-20, 1981 Course No. 535DC
RADAR FUNDAMENTALS FOR TECHNICAL MANAGERS	November 23-24, 1981 Course No. 704DC
MILITARY COMMUNICATIONS SYSTEMS	December 7-11, 1981 Course No. 806DC
A TUTORIAL ON DIGITAL COMMUNICATIONS	December 7-11, 1981 Course No. 878DC

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CONTINUING ENGINEERING EDUCATION CALENDAR

The Calendar is published bimonthly to announce a select group of courses from the general schedule. These courses present both practical applications and underlying theory.

This issue of the Calendar is devoted to selected courses in the field of communications. The next issue of the Calendar will focus on information management courses.

GENERAL INSTRUCTIONS

REGISTRATION

Tentative or final registration should be made as soon as practicable. Fill out and mail the attached registration form, or apply by letter, telephone, TELEX, or purchase order to Continuing Engineering Education Program, George Washington University, Washington, D.C. 20052 **(202) 676-6106,** the toll-free number **(800) 424-9773,** or **TELEX 64373 (International).** To facilitate registration by telephone, please mention the alphabetical priority code printed immediately to the right of the registration form.

TIME AND PLACE

Check-in will be at 8:15 a.m. on the first day in the 6th floor lobby of the University's Gelman Library, 2130 H St., N.W. (corner of 22nd and H), Washington, D.C. Classes will meet from 8:30 a.m. to 4:15 p.m. Parking is provided.

HOUSING AND MEALS

Housing and meals are not provided. However, there is a wide variety of hotels, motels, and restaurants nearby. Since hotel accommodations may be difficult to obtain, reservations should be made as early as possible. If you have difficulty obtaining reservations, we will be happy to assist you.

FEE

The fee for each course includes lecture notes, text (where listed), and supplies. Make checks and purchase orders payable to GWU, Continuing Engineering Education. Participants may delay payment until arrival.

CONTINUING EDUCATION UNITS (CEU)

Course participants will receive a Certificate of Completion indicating the number of Continuing Education Units (CEUs) awarded for the course. The CEU is a standard measurement for noncredit continuing education programs. One CEU is given for each 10 contact hours in the classroom.

TEAM DISCOUNTS

Organizations are encouraged to take advantage of fee reductions for multiple registrations for the same course. Discounts of 10% are allowed for three to four registrants, 15% for five to nine registrants, and 20% for ten or more registrants from the same organization.

SPECIAL COURSES

Most of our courses have been presented on an in-house contract basis. New courses can be developed based on the specific training needs of your organization. In either case, the cost per capita is substantially lower than advertised fees. We will be happy to provide you with additional information.

Second class postage is
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☐ Register me for course no. ___________
Please send information on courses numbered:

_________ _________ _________ _________ _________ _________

☐ I am not interested in attending these courses but please add my name to your mailing list to receive announcements of future sessions.

Course No.	Title	Date
451DC	Digital Encoding and Processing of Voice and Video	November 9-11, 1981
490DC	Switched Telephone Networks: Switching Concepts	November 9-11, 1981
790DC	TDMA Satellite System Engineering and Practice	November 9-12, 1981
865DC	Tactical Missile Guidance and Control	November 9-13, 1981
535DC	Digital Transmission Systems Engineering	November 16-20, 1981
704DC	Radar Fundamentals for Technical Managers	November 23-24, 1981
806DC	Military Communications Systems	December 7-11, 1981
878DC	A Tutorial on Digital Communications	December 7-11, 1981

MAIL TO:
Continuing Engineering Education, George Washington University, Washington, D.C. 20052

DIGITAL ENCODING AND PROCESSING OF VOICE AND VIDEO

November 9-11, 1981

OBJECTIVE

The objective of this course is to provide the engineer working in the field of digital encoding of sources with a better understanding of the concepts and techniques employed, available systems, and future possibilities.

WHO SHOULD ATTEND

This course is structured to meet the needs of the communications engineer and supervisory-level engineer involved in digital encoding and processing of voice and video signals.

DESCRIPTION

Recent advances in semiconductor technology have resulted in high-speed logic, large semiconductor memories on a chip, and high-speed microprocessors using bipolar technology. These advances have resulted in development of techniques and systems for digitally encoding voice, graphic, and video signals, as well as the digital processing of these signals. Applications to telephony are discussed.

Topics include: a comparison of pulse code modulation (PCM), adaptive delta PCM, adaptive delta modulation (DM) systems, and linear predictive coding (LPC) to encode voice signals. Graphic and video encoding systems to be compared include PCM, DPCM, DM, and transform coders. Picture quality will be compared, and coded voice quality will be demonstrated.

PREREQUISITE

Although there is no prerequisite for the course, a degree in engineering would be helpful.

OUTLINE

- Introduction
  - Quantization
  - Coding (NRZ, RZ, BRZ)
  - Digital transmission
  - Categories of speech coders
  - Synchronization
  - Synchronous communication
  - Time division multiplexing
  - Digital multiplex hierarchies
- Time Domain Coders
  - Performance criteria
  - Pulse code modulation (PCM)
  - Dithering
  - Nonuniform quantization
  - Logarithmic quantizer
  - Adaptive quantization
  - Differential PCM (DPCM)
  - Adaptive differential PCM (ADPCM)
  - Delta modulation (DM)
  - Adaptive delta modulation (ADM)
  - Variable slope delta modulation (VSDM)
  - Continuously variable slope DM (CVSDM)
  - Delay encoding
  - Nearly instantaneous companding
  - Tree encoding
  - Digitally controlled DM (DCDM)
  - Comparison of techniques
  - Transmission of non-speech signals
- Speech Coding Applications
  - Channel banks
  - Sampling theorem
  - Filter realizations
  - Framing
  - Signaling
  - Maintenance (monitoring)
  - Coding impairments
  - Circuit complexity
  - Transmission capabilities of commercial facilities
- Special Coding Techniques
  - Sub-band coders
  - Adaptive predictive coding (APC)
  - Vocoders
- Linear Predictive Coding (LPC)
  - Linear speech production model
  - Linear prediction model
  - Partial correlation (PARCOR)
  - Speech synthesis structures
  - LPC vocoder
  - Implementation algorithms
  - LPC performance
- Video Encoding
  - Source statistics
  - Receiver statistics
  - Video signal characteristics
  - Characteristics of the human visual system
  - PCM encoding of video
  - Differential PCM for video
  - Noise-feedback coder
  - Frequency-domain video encoders
  - Time-domain video encoders
  - Interframe coding
- Transform Picture Encoders
  - Picture structure
  - Transform coding
  - Linear transformations
  - Quantizing the coefficients
  - Factors affecting performance
  - Adaptive techniques
  - Picture complexity
  - Color TV encoding
  - Effect of bit errors in the coefficients
  - Comparison of coding methods
  - Hybrid coding of images

INSTRUCTOR

Bernhard E. Keiser is a consulting engineer in telecommunications and related fields. He holds a D.Sc.E.E. from Washington University in St. Louis, and is a Registered Professional Engineer in Virginia, Maryland, and the District of Columbia.

Dr. Keiser has performed studies of digital signal processors and holds two U.S. patents for voice signal bandwidth compression and expansion using time-domain principles. He has also

worked in the areas of speech channel evaluation and low bit rate speech digitization.

Dr. Keiser is the author of 24 published papers and served in a number of advanced engineering and management positions in several major corporations prior to establishing his consulting engineering practice. He is a Fellow of the IEEE, and the Washington Academy of Sciences and was recently Chairman of the Northern Virginia Section of the IEEE.

TEXT

Digital Processing of Speech Signals, by L. R. Rabiner and R. W. Schafer.

FEE

The fee for the course is $575.

Course No. 490DC

SWITCHED TELEPHONE NETWORKS: SWITCHING CONCEPTS

November 9-11, 1981

WHO SHOULD ATTEND

This course is designed for managers, supervisors, and others in the telecommunications or related industries who need a broader understanding of switching systems.

DESCRIPTION

The features of switching concepts will be explained by showing the development into more complex systems with two, three, or more stages of switching, controlled by increasingly sophisticated methods. Lectures and discussions will cover both distributed and common control; implementation will be considered both by electromechanical and electronic stored program means, with emphasis on digital switching. Analog and digital techniques will be compared.

PREREQUISITE

Although there is no prerequisite for the course, some familiarity with telecommunications terminology would be useful.

OUTLINE

Basic Concepts
- Fundamental signalling
- Parts of the basic switch
- Terms

The Switching Matrix
- Circuit Switches
    - Space Division
        - One, two, three, or more stages
    - Time Division
        - Pulse amplitude modulation (PAM)
        - Pulse code modulation (PCM) (Digital)
    - Transformation from space to time division
    - Blocking/non-blocking
- Message switches
- Future techniques

The Control
- Basic requirements
- Distributed vs. common control
- Electronic control, wired and stored program
- Common channel signalling
- Future techniques

National Networks
- Switching hierarchy
- Signalling/control
- Effects of satellite circuits
- Future techniques

INSTRUCTOR

Paul Fleming, Jr., P.E., is the Technical Director of the U.S. Independent Telephone Association. He was formerly Vice President of Telcom Engineering, Inc., and head of Telecom's Educational Services Department.

Mr. Fleming's experience includes private engineering practice as a telephone consultant, planning electronic telephone exchanges, and developing advanced communications systems.

He served nine years with companies in the International Telephone and Telegraph organization, including the ITT Communications Systems Division, where he functioned as Executive Scientist — the senior research and development position. While with ITT, he was responsible for the specification, procurement, and cutover of electronic telex and message switches in the U.S. and abroad, and served as Manager of Advanced Facilities Planning at ITT World Communications.

Mr. Fleming was an invited delegate to the five recent International Teletraffic Congresses conducted in New York, Munich, Stockholm, Melbourne, and Madrid. His papers on transmission line theory, demodulation, traffic theory, and numerous other telephone subjects have been published in the *Proceedings* of AIEE, *Transactions* of the IEEE, the Sixth, Eighth, and Ninth International Teletraffic Congresses, *Electronics, Telephone Engineer, Telephony,* and *Management,* and the Telecommunications Conference Proceedings of the Atomic Energy Commission.

Mr. Fleming taught courses in circuit design, electronics, and transmission lines during five years as an Assistant Professor of Electrical Engineering at the Universities of Arkansas and Kansas.

TEXT

Principles of Switching, by Paul Fleming, Jr. Volume 10 of *Lee's ABC of the Telephone,* Geneva, Illinois.

FEE

The fee for this course is $575.

TDMA SATELLITE SYSTEM ENGINEERING AND PRACTICE

November 9-12, 1981

OBJECTIVE

To provide participants with a comprehensive coverage of the basic design requirements of Time Division Multiple Access (TDMA) methods in satellite digital communications, and the application of these principles to specific projects.

WHO SHOULD ATTEND

Engineers, scientists, and technical managers involved in the design and development of digital communications.

DESCRIPTION

TDMA (Time Division Multiple Access) is rapidly becoming the preferred means for accomplishing digital communications with satellite links. TDMA permits maximum efficient use of the power and bandwidth available at the satellite for multiple access communications, and, in addition, possesses the flexibility needed to adapt to changing traffic demands.

TDMA is now under active consideration for use in regional and world-wide satellite communications, and many of the detailed design features of systems capable of meeting these requirements are now being resolved by hardware manufacturers.

This course provides a review of the design principles which have been established for many TDMA satellite systems and represents the most recent advances in the state-of-the-art.

PREREQUISITE

There is no specific academic requirement. However, an engineering or science degree, or equivalent experience, would be helpful.

OUTLINE

Basic TDMA principles
Single beam and multiple beam operation
Acquisition and synchronization techniques
TDMA terminal design concepts
Independent reference station design concepts
Burst modem design
Digital transmission over non-linear links
Co-channel, adjacent channel, and multipath interference
Optimized satellite design
Network connectivity considerations
Transponder hopping
Burst traffic management
Demand assigned operation
TDMA terrestrial interfaces for analog and digital network
Synchronous, asynchronous, and plesiochronous network operation
Satellite switched TDMA principles

INSTRUCTORS

S.J. Campanella, Ph.D., is the Director of the Communications Processing Laboratory of COMSAT Laboratories, where he is responsible for the technical orientation of the efforts pursued in the Speech Processing, Image Processing, Multiple Accessing, Digital Control and Modulation Techniques Departments. Before joining COMSAT he was manager of the Electronics Research Center at Melpar Inc. and an electronic scientist at the Naval Research Laboratory involved in sonar signal processing. He has made numerous technical contributions in the areas of communications processing for SCPC, FDMA, and TDMA satellite use. In particular he has contributed significantly to developing techniques for advanced network control concepts for TDMA and satellite switched TDMA, TDMA terminal development, image processing using orthogonal transformation techniques, digital speech interpolation for enhancing satellite link capacity, on-board baseband processing, echo control by echo cancellation, speech source encoding using deltamodulation, adaptive differential pcm, and nearly instantaneous companding. He has most recently been responsible for the technical direction of the INTELSAT TDMA field trials in the Atlantic Ocean Region, development of TDMA Traffic and Reference Station concepts, and an intensive effort to develop a new low cost TDMA concept.

Roger J. Colby received an honors degree in electrical and electronic engineering from Lanchester Polytechnic, England, in 1971. He is with the British Post Office, Satellite Systems Division, where he was an executive engineer at the BPO Laboratories at Goonhilly Earth Station from 1971 to 1978. He was responsible for a team researching digital communications for satellites and participated extensively in CEPT and ESA studies concerning the TDMA aspects of the European OTS and ECS satellites. Currently Mr. Colby is an INTELSAT nominee from the United Kingdom assigned to the Communications Processing Laboratory at COMSAT. In this capacity he is involved with the INTELSAT TDMA field trial and has become team leader of COMSAT's support for the revised INTELSAT TDMA/DSI specifications. He is currently completing study for a Ph.D. in hybrid digital modulations.

FEE

The fee for this course is $645.

TACTICAL MISSILE GUIDANCE AND CONTROL

November 9-13, 1981

WHO SHOULD ATTEND

Engineering personnel responsible for or involved in the design, research, and/or management of tactical missile systems.

DESCRIPTION

A tactical missile is typically fired in a direction approximately towards the target. Subsequently, steering commands from the guidance system are utilized by the missile autopilot to produce accelerations which create missile maneuvers designed to ensure proper missile-target encounter conditions.

This course is intended to present the basic concepts associated with classical navigation-guidance laws and their interrelationships with classical control theory in the design of tactical guided missile systems. Utilizing both lectures and workshops, fundamental guidance concepts, equations of motion, and basic missile autopilot design will be covered. Analytical tools and methods for analyzing various tactical missile configurations are presented along with discussions of practical engineering solutions.

The course begins with a review of required mathematical basics such as matrices, transfer functions, and coordinate system transformations. Analytical tools for determination of system performance and stability are presented. Included among the techniques are: The Routh Criterion, the Root-Locus Method, Bode Diagrams, and the Nyquist Stability Criterion. The fundamentals of missile aerodynamics are reviewed and missile equations of motion are developed. Classical guidance techniques such as beam-rider, pursuit, and proportional navigation are examined in detail. For various target configurations such as a non-maneuvering as well as a maneuvering target, missile acceleration requirements are examined. Sensitivities to initial heading error, system time constants, and non-linear phenomena such as an acceleration-limited missile are examined. Optimal and adaptive control concepts and their application to the tactical missile problem are briefly discussed.

PREREQUISITE

There is no formal prerequisite for this course. Participants should bring a pocket calculator for use in the classroom.

OUTLINE

1st Day

- Introduction
- Linear algebra: matrices
- Coordinate systems
- Transfer functions
- Frequency response
- Bode diagrams
- Nyquist Stability Criterion
- Routh's Criterion
- Workshop

2nd Day

- Root-locus
- Missile aerodynamics
- Equations of motion
- Aerodynamic transfer functions
- Workshop

3rd Day

- Missile transducers
- Constant bearing course
- Pursuit guidance
- Workshop
- Proportional navigation
- Missile acceleration requirements
- Workshop

4th Day

- Acceleration limited missile
- Non-maneuvering targets
- Maneuvering targets
- Homing guidance loops
- Autopilot design
- Workshop

5th Day

- Line-of-sight guidance loops
- Guidance loop stability
- Noise effects
- Workshop
- Optimal control
- Adaptive control

INSTRUCTORS

Donald W. Sutherlin, Ph.D., is a Research Aerospace Engineer at the U.S. Army Missile Command, Huntsville, AL. He is also an Adjunct Associate Professor of Electrical Engineering at the University of Alabama, Huntsville, AL. He holds a Ph.D. in Electrical Engineering, from Auburn University. In addition to the University of Alabama, Dr. Sutherlin has teaching experience at Auburn University and the University of Tennessee. He is involved both nationally and internationally with missile systems and is currently serving as Director of two NATO efforts involving tactical missile systems. He is the author of a number of journal and symposium publications.

Harold L. Pastrick, Ph.D. He received his degree from California Western University. He was with the Army Electronics Command involved in avionics for Army helicopters. He joined the Army Missile Command where he was active in research, development, and evaluation of guidance and control systems for a number of the Army's tactical missiles. In 1979 he became Staff Specialist and Assistant to the Director, Land Warfare, Office of the Undersecretary of Defense for Research and Engineering, responsible for managing the research, development, and acquisition of major weapon systems in the tactical warfare area. He is now Vice President for Engineering, and Consulting Engineer for the Controls Dynamics Company involved in weapon system research and engineering. He is a Registered Professional Engineer in the State of Alabama, a Lecturer in the School of Science and Engineering at the University of Alabama, and Lecturer and Research Advisor at the Southeastern Institute of Technology, Alabama.

FEE

The fee for this course is $735.

DIGITAL TRANSMISSION SYSTEMS ENGINEERING

November 16-20, 1981

WHO SHOULD ATTEND

This course is designed for engineers, managers, and others who need a better working knowledge of the principles and the current and future applications of digital transmission systems engineering. The course will be of particular value to those who are currently planning transmission systems based on use of the rapidly growing digital technology.

DESCRIPTION

The course covers the numerous advantages of digital transmission, as compared to analog transmission, which have led to rapid and extensive changes in many practices associated with the engineering of communications system design.

PREREQUISITE

There is no prerequisite for this course. Although a degree in engineering or science would be helpful, the principles, techniques, and design practices will be presented so that participants without an extensive background in mathematics may gain a better understanding of the engineering applications of digital transmission systems.

OUTLINE

FIRST DAY

- Introduction to and comparison of analog and digital transmission systems. Applicable standards and hierarchies.
- Analog to digital conversion techniques: Pulse Code Modulation (PCM), Delta Modulation (DM), and CVSD; companding and multiplexing; equipment examples.
- Transmission media and effects: satellite, line-of-sight, troposcatter, HF, and cable. Sources of degradation in digital transmission.
- Performance allocations: user-to-user reference channels. Performance parameters: bit error rate, block error rate, error seconds, propagation outages, equipment unavailability, and bit count integrity.

SECOND DAY

- DTE/DCE interfaces: asynchronous, isochronous, synchronous.
- Time division multiplex design and performance: frame synchronization, pulse stuffing, transitional encoding.
- Baseband coding: NRZ, bipolar, diphase, partial response signaling. Cable systems with regenerative repeaters, adaptive equalization and clock recovery.
- Transmission over analog multiplex and radio systems: VF channel and group modems, baseband modems with FM radios, data under voice (DUV) and data above voice (DAV) modems; applicable modulation techniques and circuit conditioning.
- CCITT and U.S. standards: differences in multiplex and modem specifications.
- Monitoring and control: pseudo error, SNR and eye pattern. Control of diversity combining and redundancy switching. Automatic fault isolation and restoration.

THIRD DAY

- Transmission channel modeling: statistical concepts, propagation phenomenology.
- Line-of-sight transmission: Barnett-Vigants, Rice-Nagakami models. Fading; durations, rate, cumulative outages, frequency selectivity, and anomolous propagation on LOS paths.
- Tropospheric scatter and diffraction transmission: modeling of the fading dispersive channel; wide sense stationary with uncorrelated scattering; Rayleigh and lognormal fading, fading statistics.
- Satellite transmission: modeling channels, scintillation phenomena, meteorological effects.
- Digital transmission techniques: bit error rate, bandwidth efficiency, concept of the signal constellation, and comparison of AM, FSK, PSK, and AM-PM schemes in actual radio designs. Tradeoffs.

FOURTH DAY

- Optimum and practical receiver structures: conventional demodulators for LOS and satellite channels. Time gating, sequential decoding, tail cancellation, and adaptive feedback equalization for dispersive channels.
- Diversity operation: space, frequency, and polarization diversity, operation and performance. Combiner techniques; square law, maximal-ratio, and selection.
- Terrestrial radio link design: topography, path calculations-fade margin, system gain. Effects of co-channel and adjacent channel interferences, and of rain; dependence on operating frequency, cross-polarization.
- Mobile communications system design: cellular structure, TDMA, equipment constraints.
- Satellite communications system design: multiple access techniques, space segment/earth terminal tradeoffs.

FIFTH DAY

- Network timing and synchronization: time and frequency standards; independent clocks, master/slave, mutual synchronization, external reference, LORA C and Global Positioning System; buffering requirements.
- Testing for performance verification: bit error rate confidence levels, reliability, digital voice and digital data performance.
- Survey of U.S. and foreign digital transmission systems.
- Future considerations: advanced voice processing and multiplexing. Future transmision media: fiber optics, millimeter waveguide, short range mm radios, intersatellite communications.

INSTRUCTORS

David R. Smith is an electrical engineer with the Transmission System Engineering Division of the Defense Communications Engineering Center (DCEC), where his work involves analysis and systems design of digital transmission facilities for the Defense Communications System. His experience includes design and applications engineering for PCM and digital multiplex equipment, microwave radio and modem equipment, and network synchronization techniques. Dr. Smith has written several technical papers in the field of digital transmission systems.

John L. Osterholz is a communications system engineer with the Transmission System Engineering Division of DCEC. He is currently involved in the design and system analysis of terrestrial

digital transmission equipment with emphasis on the effects of propagation and spectrum efficiency on multichannel digital communications. His experience includes design and analysis of digital signal processing for troposcatter system and link engineering criteria. Mr. Osterholz was previously involved in the design and analysis of telemetry systems for deep space applications. Prior to that, he was concerned with the effects of meteorology on the guidance requirements for tactical missile systems. Mr. Osterholz has published a number of papers in the field of communication channeling, modeling, propagation, and transmission system design.

FEE

The fee for the course is $735.

Course No. 704DC

RADAR FUNDAMENTALS FOR TECHNICAL MANAGERS

November 23-24, 1981

OBJECTIVE

This course is designed to provide a working knowledge of radar fundamentals to technical managers who are unfamiliar with the subject, yet who are or may be involved in radar-related projects.

WHO SHOULD ATTEND

Technical managers, engineers, and scientists who need to have a better understanding of radar fundamentals.

DESCRIPTION

As program and project management becomes more complex, technical managers frequently find themselves associated with systems or parts of systems with which they are not familiar. This is particularly true in large engineering and scientific projects.

A first-principles approach will be employed to develop theoretical aspects of radar. Application of these theoretical aspects to radar design problems will be explored, and their use in current systems discussed. Specifically included are modern radar concepts such as phased arrays, pulse doppler, MII mapping, synthetic aperture radar, and pulse compression. Techniques will be discussed which will result in "rules of thumb" useful for managers.

PREREQUISITE

There is no prerequisite for this course. A degree in engineering or science, or equivalent would be helpful since some presentations will assume a background in basic engineering mathematics.

OUTLINE

- Introduction (approach to objective)
- Arithmetic and mathematical shortcuts
  decibels, RMS, Fourier transforms,
  probability and statistics, approximations
- Fundamental electromagnetics
  radiation, modulation, phase
  (coherence and incoherence)
- Radar range equation
  simple theory, derivation manipulation,
  jammer equations, designing a radar
- Detection theory
  statistical basis, signal-to-noise, P_d vs P_{fa},
  integration, some complexities, tables
- Antennas
  simple theory, dishes, arrays, hybrids, design philosophies,
  real world examples
- Waveforms
  single pulse, pulse trains, ambiguity functions, weighting,
  pulse compression, designing waveforms

INSTRUCTOR

John C. Toomay, Major General, U.S. Air Force (retired), has spent most of his career as a research and development manager. He specialized in radar as a program manager at Rome Air Development Center, Advanced Research Projects Agency, and the Air Force Space and Missile Systems Organization. He has received several awards for R&D management and is author of *Radar Fundamentals for R&D Managers.*

FEE

The fee for this course is $500.

MILITARY COMMUNICATIONS SYSTEMS

December 7-11, 1981

OBJECTIVE

The objective of this course is to present, in an integrated manner, theory basic to the understanding and design of military communications systems. General principles rather than specific systems will be stressed, although illustrative examples based on unclassified aspects of current or recent implementations will be included. Participants should gain a practical understanding of the performance trade-offs involved in the use of adaptive antennas, error coding, spread spectrum, and encryption techniques.

WHO SHOULD ATTEND

Engineers, managers, and scientists who are concerned with designing or using communication systems to accomplish or overcome jamming, interception, and message security.

DESCRIPTION

A number of techniques have been implemented to increase the effectiveness of military communications. These techniques have several thrusts: reducing the likelihood of signal intercept by transmitting broadband (low power density) signals; minimizing the effects of jamming through the use of error coding and spread spectrum and placing receive antenna nulls on the jammers, while simultaneously placing the main antenna beam on the desired signal source; and using encryption to delay or deny knowledge of information to unintended recipients.

The other side of this contest is equally important and involves denying or degrading communication by others through jamming of one sort or another. In either case — whether one's concern is electronic countermeasures (ECM) aimed at disrupting communications, or electronic countermeasures (ECCM) designed to ensure continuation of communications — there is also a need for electronic support measures (ESM) for listening in electronically to determine presence, frequency band, and location of unknown emitters. Knowledge of all three aspects — ECM, ECCM, ESM — is vital to participants on either side of the electronic battlefield.

This course will present an integrated treatment of several key aspects of military communication systems addressed from the ECM, ECCM, and ESM points of view. Topics covered include jamming effectiveness, direct-sequence spread spectrum for both anti-jamming (AJ) and low probability of intercept (LPI), frequency-hop spread spectrum, adaptive antenna systems, intercept systems, and an introduction to cryptography, along with its impact on error, synchronization, and AJ performance.

PREREQUISITE

A degree in electrical engineering or equivalent experience.

OUTLINE

Review of electromagnetic wave propagation and analog and digital modulation
Effectiveness of various types of jamming against amplitude modulation (AM), frequency modulation (FM), phase modulation (PM), and frequency shift keying (FSK) systems
Summary of error correcting codes — capabilities, limitations, and trade-offs
Spread Spectrum Systems for LPI and AJ
- Direct sequence (DS) — basic principles,
  pseudo-noise (PN) sequences, concealment of PN waveforms, error probabilities, acquisition techniques, PN networks, and mutual interference
- Frequency hopping (FH) — fast *vs.* slow hop, error coding with and without interleaving, bit and word error probabilities, partial-band and repeater jamming, acquisition and FH networks
- Hybrid DS/FH systems
- Comparison of DS and FH performance

Intercept Systems
- Elementary detection theory — ideal case, probabilities of detection and false alarm
- Detection by radiometer and cross correlator
- Frequency estimation - channelized, scanning superhetrodyne, and other receiver structures

Adaptive Antenna Systems
- Basic principles of noise correlation, adaptive beam forming, null steering
- Time- and frequency-domain processing
- Application of general theory to sidelobe canceller, adaptive notch filter

Cryptography
- Codes and ciphers
- Basic ciphers for communication — block and stream ciphers
- Comparison of linear and nonlinear shift-register generators
- Cipher-induced problems, errors, degraded synchronization, and anti-jamming

INSTRUCTOR

Djimitri Wiggert, Ph.D., is on the senior professional staff, Applied Physics Laboratory of the Johns Hopkins University and the faculty of the Evening College of the Johns Hopkins University. His work on military communications systems has included system engineering for the Defense Communications Agency, development of AJ data links and advanced communications technology for the Defense Advanced Research Project Agency (DARPA) and the United States Army, and C^3 system design for the United States navy. He is an Associate Professorial Lecturer at the George Washington University, and a Senior member of the IEEE. Dr. Wiggert is author of *Error Control Coding and Applications,* Artech House, 1978.

TEXT

The text for this course is *Principles of Military Communications Systems,* by D.J. Torrieri.

FEE

The fee for this course is $745.

A TUTORIAL ON DIGITAL COMMUNICATIONS

December 7-11, 1981

WHO SHOULD ATTEND

Engineers, programmers, and technical managers who need practical and timely information about the modern technology of digital communications and the important concepts underlying this rapidly evolving field. It is for those who want insight, intuition, and clarity, rather than a superficial overview.

DESCRIPTION

This tutorial presents the principles underlying the wide range of technologically important areas of digital communications and the techniques and applications of current and future importance. The intent is to give clarity, insight, and intuition into digital communications and to describe the important features of existing and planned communication systems. The topics begin from basics without assuming prior familiarity with jargon and acronyms. The material covered should enable the participant to work with applications of current and emerging developments in digital networks.

PREREQUISITE

Some familiarity with the basic concepts used in undergraduate electrical engineering programs would be helpful. This includes frequency domain description of signals and filters and the basic notions of probability. Skill in mathematical analysis is not needed.

OUTLINE

Introduction to digital communications
  scope, impact, advantages, overview
Digital coding of analog signals
  filtering, sampling, reconstruction, quantization, granular
  and overload noise, companding dynamic range, segmented
  mu & A laws, codecs
Multiplexing and digital hierarchy
  combining bit streams for digital highways
  T-carrier systems, U.S. vs. European hierarchy
  framing and synchronization
  digital time-division switching
Fundamental limits on data transmission
  capacity of a channel, bandwidth, energy per bit
  noise density, bit rate, baud rate, trade-offs
  bandwidth, power
Errors and error control
  error correcting codes
  parity check codes, Hamming codes,
  block versus convolutional codes,
  encoding and decoding
Reduced bit rate coding of analog sources
  delta modulation, predictive encoding,
  transform coding, adaptive methods,
  LPC and other vocoders, secure voice
Digital signal processing in communications
  digital filtering, adaptive processing,
  digital speech interpolation, echo cancellation
  programmable signal processors
Digital modulation fundamentals
  Nyquist criterion, rolloff,
  intersymbol interference,
  eye patterns, error probability
  duobinary systems
  regenerative repeaters
Digital carrier modulation
  amplitude, phase, and frequency shift keying
  quadrature amplitude modulation,
  signal constellations,
  performance comparisons
Voiceband data modems
  scrambling, modulation,
  adaptive equalization, decision feedback,
  fractionally spaced equalizers
Digital Transmission Media
  coaxial cable, optical fiber,
  microwave relay,
  satellite communications
Privacy and security
  digital encryption principles, block ciphers
  U.S. Data Encryption Standard (DES)
  modes of operation, chaining, cipher feedback,
  authentication, signatures, transaction verification
  public key encryption, principles, applications
  multiple access techniques
Military communication systems
  tactical channels,
  spread spectrum,
  crypto
Data Communication Systems
  overview, typical users,
  system configurations,
  protocols, functions and procedures
Data Signals
  terminals, ASCII, modems, concentrators, statistical
  multiplexing
  point-to-point vs. multipoint
  typical small data networks configuration
Protocols for error control
  ARQ, windows, HDLC, BISYNC
Layered protocols
  pro and con
  X.25 and other standards
  current and planned protocols
Common user concerns
  interrelationships between protocols and transmission systems
  performance issue, reliability, throughput
Future directions
  present and future digital systems and networks,
  implications of satellite and fiber
  home and office wideband digital services,
  teleconferencing and other emerging digital services
  data networks of the future

INSTRUCTORS

Allen Gersho recently became Professor of Electrical and Computer Engineering at the University of California, Santa Barbara. From 1963 to 1980 he was at Bell Laboratories where he was engaged in basic and applied research in digital communications, data transmission, quantization, and signal processing. He is the author of numerous published articles and was co-recipient of the Guillemin-Cauer Prize Paper Award in 1980.

Dr. Gersho was Editor of the IEEE Communications Magazine from 1978 to 1980 and is currently an Associate Editor of the IEEE Transactions on Communications. He has taught at Cornell University, Columbia University, City University of New York, and UCLA and has been a frequent guest lecturer at universities. He is known for the clarity of his writings and presentations.

Bruce McNair is a member of the Technical Staff at Bell Laboratories where he has been involved with various aspects of digital transmission and data communications including terminal and host communications in public data networks. Before joining Bell Labs, he was involved with ECCM and secure voice and data transmission aspects of the SINCGARS radio system at the U.S. Army Communications R&D Command. He was previously at ITT Defense Communications Division.

Mr. McNair has recently been the instructor for an in-depth course on data communications for Bell Labs engineers.

FEE

The fee for this course is $745.

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Harold Liebowitz, *Dean*

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873DC	Workshop in Data Communications for Microcomputers	November 30-December 4, 1981
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671DC	Grounding, Bonding, and Shielding	December 7-8, 1981
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617AG	Japanese Methods for Productivity and Quality	December 7-10, 1981
390DC	Solar Heating and Cooling	December 7-11, 1981
664DC	Synthetic Aperture Radar	December 8-11, 1981
859DC	Application and Control of Electric Motors	December 9-11, 1981
487DC	Mini/Microcomputers/Processors for Non-Electrical Engineers	December 9-11, 1981
553DC	The Computer: Micrographics Interface COM and CAR	December 14-15, 1981
558DC	Analysis of Variance	December 14-16, 1981
800DC	Telecommunication Product Standards	December 14-16, 1981
388DC	Software Design for Data Communication Systems	December 14-16, 1981
705DC	Software Engineering and Quality Assurance	December 14-18, 1981
005DC	Statistical Methods in Reliability	December 14-18, 1981
366DC	Federal Telecommunications Policy	December 15-18, 1981
812DC	Productivity Gains Through Material Handling	December 17-18, 1981

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